Slide 1

5.2.1 Kinematics of circular motion

Learning outcomes	Additional guidance
Learners should be able to demonstrate and apply their knowledge and understanding of:	
(a) the radian as a measure of angle	M4.7
(b) period and frequency of an object in circular motion	
(c) angular velocity ω, $\omega = \frac{2\pi}{T}$ or $\omega = 2\pi f$	

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

Lesson 1. Angular velocity

0:00:00

STARTER: How many Olympic sports can you name where object/people move in a circuit path?

Kilo 10³
Mega 10⁶
Giga 10⁹

Extension: What do they all have in common in terms of force and motion?

Key point

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Slide 2

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

0:00:00

STARTER: Draw an object moving in a circular path. Label, with arrows

(a) centripetal force, F
(b) velocity, v
(c) acceleration, a

Kilo 10³
Mega 10⁶
Giga 10⁹

What are the criteria for <u>constant</u> <u>acceleration</u> circular motion?

Key point

Criteria for circular motion:
- Force must be perpendicular to velocity
- Resultant centripetal force acting towards centre of circle
- Centripetal acceleration towards centre of circle
- For constant acceleration, speed must be constant

How can an object moving in a circular path be accelerating when its speed is constant?

phet

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Slide 3

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

Radians

0:00:00

The SI unit for angle is the radian. Although degrees is commonly used.

A radian is defined as: The angle **subtended** by a circular arc with length equal to the radius of a circle.

Q: How many degrees is 1 radian?

1 rad

▲ **Figure 2** An angle of 1 radian

Key point

angle in radians = $\frac{\text{arc length}}{\text{radius}}$ = $\frac{2\pi r}{r}$

If we consider 1 whole circle...

angle in radians = 2π

Therefore 360 degrees = 2π radians
To convert from degrees to radians, multiply by 2π/360 or π/180.
To convert from radians to degrees, multiply by 360/2π or 180/π.

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Slide 4

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

Lesson 1. Angular velocity

SAQ

2 a Convert the following angles from degrees into radians: 30°, 90°, 105°.
   b Convert these angles from radians to degrees: 0.5 rad, 0.75 rad, π rad, $\frac{\pi}{2}$ rad.
   c Express the following angles as multiples of π radians: 30°, 120°, 270°, 720°.

Answer

Key point

Kilo 10³
Mega 10⁶
Giga 10⁹

a 0.52 rad, 1.57 rad, 1.83 rad
b 28.6°, 43.0°, 180°, 90°
c $\frac{\pi}{6}$ rad, $\frac{2\pi}{3}$ rad, $\frac{3\pi}{2}$ rad, 4π rad

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Slide 5

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

0:00:00

Angular velocity

The velocity of the cabins is different from velocity of part of the spokes because they are different distances from the centre.

A more convenient method to describe the movement is **angular velocity**.

Key point

angular velocity is defined as the rate of change of angle.

rads⁻¹   rad

$\omega = \frac{\theta}{t}$ What are the units?

rad
s

$\omega = \frac{2\pi}{T}$ If we consider a full circular rotation.....

$T = \frac{1}{f}$

$\omega = 2\pi f$ Using the equation for T, time period, angular velocity can be expressed as.........

f (Hz)

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Slide 6

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

0:00:00

ACTIVITY:
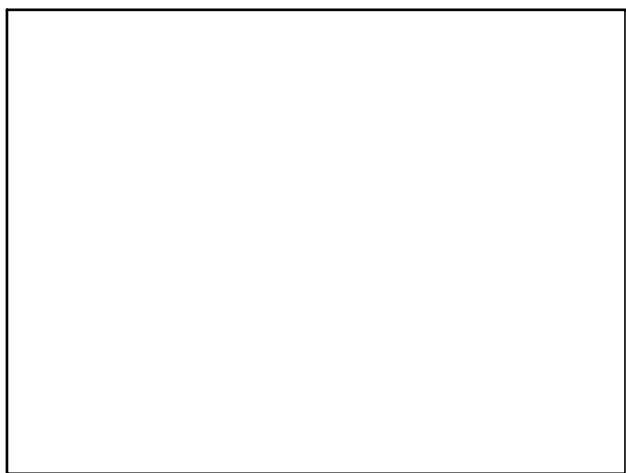Try the circular motion questions 2 and 3.

Kilo 10³
Mega 10⁶
Giga 10⁹

Extension: Lowe P66. Ex 8.1 8.2 8.3

Key point

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Slide 1

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

plenary   ▶ 0:00:00

rpm stands for revolution per minute.

What is the angular velocity of this car engine in rad s-1?

576 rad s⁻¹

Kilo 10^3
Mega 10^6
Giga 10^9

Key point   Why might your answer not be accurate?

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Slide 2

(6) M - Define the radian as a measure of angle
(7) S - Convert angle from degrees into radian and vice versa
(8) C - Apply the equation for angular velocity

plenary   ▶ 0:00:00

What is the angular speed of a point on the Earth's equator?

A 7.3×10^{-5} rad s⁻¹
B 4.2×10^{-3} rad s⁻¹
C 2.6×10^{-1} rad s⁻¹
D 15 rad s⁻¹

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{24 \times 60 \times 60}$$
$$\omega = 2\pi f$$

A fairground roundabout makes nine revolutions in one minute. What is the angular speed of the roundabout?

A 0.15 rad s⁻¹
B 0.34 rad s⁻¹
C 0.94 rad s⁻¹
D 2.1 rad s⁻¹

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{(9/60)} =$$

What is the angular speed of a car wheel of diameter 0.400 m when the speed of the car is 108 km h⁻¹?

A 75 rad s⁻¹
B 150 rad s⁻¹
C 270 rad s⁻¹
D 540 rad s⁻¹

1. a
2. c
3. b

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Sep 18-11:00